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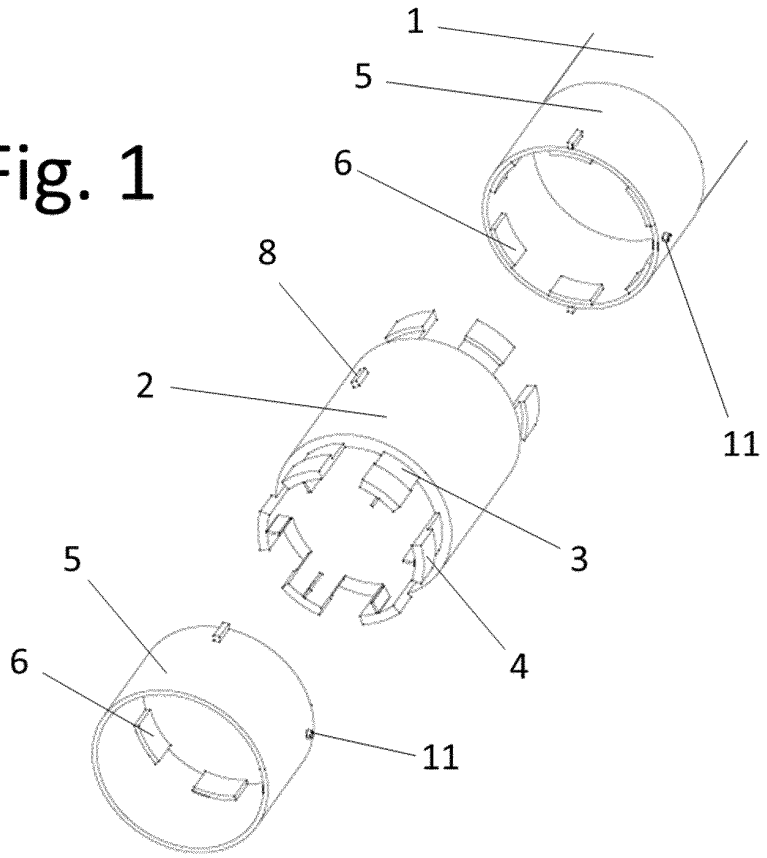
(54) JOINT FOR CONCRETE-FILLED STEEL TUBULAR STRUCTURES

(57) Joint for concrete-filled steel tubular structures, of the type that joins two axially-aligned tubular steel segments (1). It comprises a tubular connector (2) between both steel segments (1), in a tongue and groove connection with each steel segment (1). The connector is locked against rotation by the concrete (10) filling.

The male part of each tongue and groove connection comprises a circular wall (3) where at least two projections (4) are placed, the projections (4) being evenly distributed around the outside of the circular wall (3).

The female part has a shell (5), the inside of the shell carrying at least two teeth (6) that define a circular hole (7) for the insertion of the circular wall (3); so the projections (4) fit between and behind the teeth (6).

Fig. 1



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Description

PURPOSE OF THE INVENTION

[0001] The present invention refers to a new type of joint system for concrete-filled steel tubular structures (CFST), where steel tubes are assembled and later filled with concrete.

[0002] The joint system connects two co-axial steel tubes improving the construction process of CFST structures, facilitating the connection so both tubes are readily attached to each other. This joint allows the tubes to support themselves whilst the structure is being built and the concrete is still to be poured. The system includes a mechanical device that enables the rotation of the connector and keeps it in place until the concrete hardens. Once the concrete is poured and hardened, the joint is permanently locked by the concrete.

APPLICATION FIELD

[0003] The field of application of the invention is construction, more specifically the construction of composite steel and concrete structures, preferably but not limited to civil engineering, buildings and windmills.

BACKGROUND INFORMATION

[0004] Composite steel and concrete structures are formed by concrete and steel elements so they both provide their best features and the structure profits from them. Usually, the steel part is built first, typically by joining steel segments of a manageable size. Those segments are transported to site and assembled in situ to form the final structure. Therefore, there is a need to join all segments before pouring or applying the concrete. Joints are usually formed by welding, riveting or other similar operations.

[0005] The most used steel and concrete composite is called reinforced concrete, where several bars of steel are embedded in the concrete mass. Another is called concrete-filled steel tubular structures (CFST) which, as its name states, requires steel tubes filled with concrete. In this kind of structures, the tubes need to be correctly connected and sealed before the concrete is poured. CFST are increasingly used in civil engineering structures as they are cheap, provide a good performance and are easily built.

[0006] As said, CFST structures are built in two phases. First, the steel structure is built using steel segments, and then a sufficiently liquid concrete is poured inside.

[0007] This type of structures has the following advantages:

1. During the first construction-phase the structure is lighter, allowing an easier installation and reducing the equipment cost needed for the installation (e.g. cranes, formwork, support structures, etc.).
2. The concrete filling adds weight and stiffness to the final structure.
3. The final structure has a higher grade of fire resistance and better behavior against collision forces than a traditional steel structure.
4. Any corrosion of the steel elements is easily detected.

[0008] Usually, the joining of the different steel segments in CFST structures are made in a conventional way, using welded or bolted connections.

SUMMARY OF THE INVENTION

[0009] The present invention refers to a new type of joint for CFST structures. It comprises a twist lock between the two steel segments to be connected and a connector placed between them, which is locked against rotation by the concrete filling once it is hardened. A mechanical device is needed to rotate the connector and put it in the right position. This device remains in the structure until the concrete has hardened and prevents the connector from rotating.

[0010] The present invention improves the construction process of CFST structures enabling an easy and fast installation of the steel part of the structure. The mechanical device that rotates the connector can be actuated manually or remote control activated.

[0011] The joint for concrete-filled steel tubular structures is of the type that joins two axially-aligned tubular steel segments. This joint also comprises a tubular connector between both steel segments, in a tongue and groove connection with each steel segment.

[0012] The male part of each tongue and groove connection comprises a circular wall where at least two projections are placed, usually between two and four. The projections are evenly distributed around the outside of the circular wall.

[0013] The female part has a shell, the inside of the shell carrying at least two teeth that define a circular hole for the insertion of the circular wall. The projections fit between the teeth, so they can pass through them. They also fit behind the teeth so they can be placed in a twist lock.

[0014] The connector is locked against rotation by the concrete filling once the concrete is hardened.

[0015] In a preferred embodiment, the circular wall is not fully round in the inside. It might include elements (rivets, nails, profiles, etc.) to increase the rotational stiffness between the connector and the concrete.

[0016] Each tongue and groove connection might comprise a seal in a contact surface between the connector and the steel segment.

[0017] In another preferred embodiment, the connector has a male part on each side, so the steel segments both have female parts.

[0018] The connector and the steel segments might have handles or platen marks for attachment of a me-

chanical tightening device.

[0019] The connector and the steel segments might have valves to check that the joint is fully filled with concrete.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] A set of drawings is attached in order to illustrate several preferred but not limiting embodiments.

Figure 1: Perspective view of an exemplary embodiment.

Figure 2: Different steps (A-F) of the building of a pillar with an embodiment of the invention, showing the connection between the different steel segments.

A-B: Insertion of connector inside of one of the steel segments
C: Insertion of the second steel segment
D: Rotation and temporary lock of the connector with a mechanical device
E: Concrete placement
F: Removal of the mechanical tightening device once the concrete is hardened

Figure 3: Different steps (A-F) of the building of 3D truss tower with an embodiment of the invention, showing the connection between the different steel segments.

A-B: Insertion of connector inside of one of the steel segments
C: Insertion of the second steel segment
D: Rotation and temporary lock of the connector with a mechanical device
E: Concrete placement
F: Removal of the mechanical tightening device once the concrete is hardened

Figure 4: Cross section of an example of male part.

Figure 5: Cross section of two examples of female parts (A-B).

DETAILED DESCRIPTION

[0021] The following embodiments are described in sufficient detail to enable those skilled in the art to practice the invention. However, other embodiments may be utilized. Mechanical, procedural, and other changes may be made without departing from the spirit and scope of the invention.

[0022] In figure 1 a first embodiment of the joint is shown. It comprises two tubular steel segments (1) and one tubular connector (2). The connector (2) is placed between both steel segments (1) so their respective holes are axially aligned. The three elements are connected through a tongue and groove connection and locked against rotation, once correctly placed, by the concrete filling (10).

[0023] In the preferred embodiment, both steel segments (1) comprise a female part whilst the connector (2) has a male part on each side. It should be considered that any other combination is possible, including using a connector (2) with a male and a female part.

[0024] A transversal section of an example of male part is shown in figure 2. It comprises a circular wall (3) where at least two projections (4) are placed. The projections (4) are evenly distributed around the outside of the circular wall (3). It is possible to include elements (9) that increase the rotational stiffness between the connector (2) and the concrete filling (10).

[0025] An example of female part is shown in figure 3. It comprises a shell (5), whose external shape is irrelevant. For instance, it can be round or squared. The inside of the shell (5) carries several teeth (6) that define a circular hole (7). This circular hole (7) is slightly bigger than the circular wall (3) of the male part so the circular wall (3) fits inside the circular hole (7). The number of teeth (6) is normally the same as the number of projections (4) of the male part. The projections (4) fit between and behind the teeth (6), so they can be placed in a twist lock.

[0026] As the joint has a connector (2) that is attached to two steel segments (1), the placing of teeth (6) and projections (4) has to allow for the insertion of two male parts in the correspondent female parts at the same time.

[0027] Once the teeth (6) and projections (4) have been correctly placed, each tooth (6) passing between two projections (4), and getting to their opposite side, the connector (2) is rotated in order to align the teeth (6) and projections (4). The connector (2) and the steel segments (1) may have handles or platen marks (8) for hoisting or other tasks, that also allow a mechanical tightening device (12) to rotate and temporarily lock the joint system while the steel structure is installed. The platen marks (8) also allow to check for the correct rotational position between the connector (2) and the steel segments (1).

[0028] Once the concrete (10) is poured and has set, the connector (2) can no longer rotate so the joint is firmly secured. The mechanical tightening device (12), and platen marks (8), if desired, can then be removed.

[0029] A seal may be placed in any contact surface between the connector (2) and the steel segment (1), e.g. one or more circular rubber-seals. This seal improves the sealing of the joint during the concrete pouring.

[0030] The connector (2) and the steel segments (1) might have valves (11) which allow air to escape to ensure that the joint system and the steel segments are fully filled with concrete (10). The valves can also be used to pump concrete into the system.

Claims

1. Joint for concrete-filled steel tubular structures, of the type that joins two axially-aligned tubular steel segments (1) **characterized in that** it also comprises a tubular connector (2) between both steel segments (1), in a tongue and groove connection with each steel segment (1),
wherein the male part of each tongue and groove connection comprises a circular wall (3) where at least two projections (4) are placed, the projections (4) being evenly distributed around the outside of the circular wall (3);
the female part has a shell (5), the inside of the shell carrying at least two teeth (6) that define a circular hole (7) for the insertion of the circular wall (3); so the projections (4) fit between and behind the teeth (6) so that concrete (10) might be poured to fill the joint and lock it against rotation.

2. Joint, according to claim 1, wherein the tubular steel segments (1) or the tubular connector (2) comprise elements (9) that increase the rotational stiffness between the connector (2) and the concrete (10).

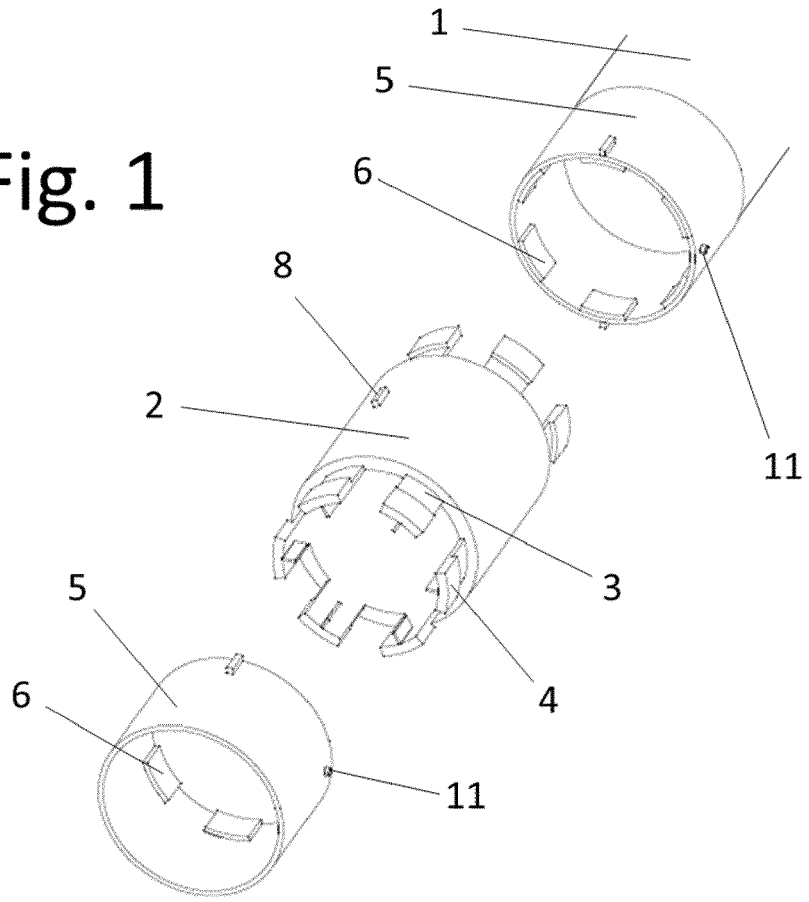
3. Joint, according to claim 1, wherein each tongue and groove connection comprises a seal in a contact surface between the connector (2) and the steel segment (1).

4. Joint, according to claim 1, wherein the connector (2) has a male part on each end.

5. Joint, according to claim 1, wherein the connector (2) and steel segments (1) have handles or platen marks (8) for attachment of a tightening device.

6. Joint, according to claim 1, wherein the connector (2) and steel segments (1) have valves (11) to check that the joint is fully filled with concrete.

Fig. 1



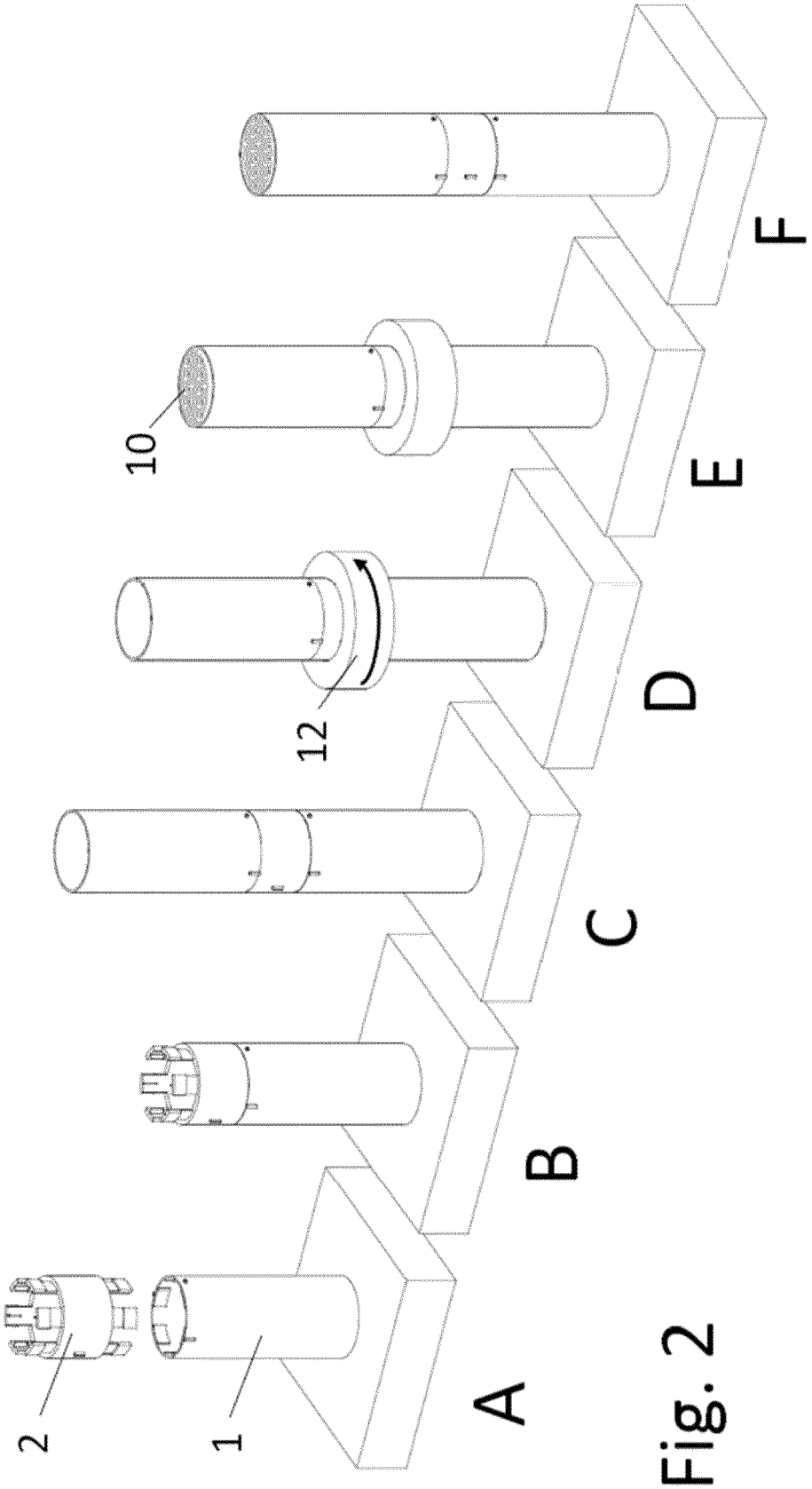


Fig. 2

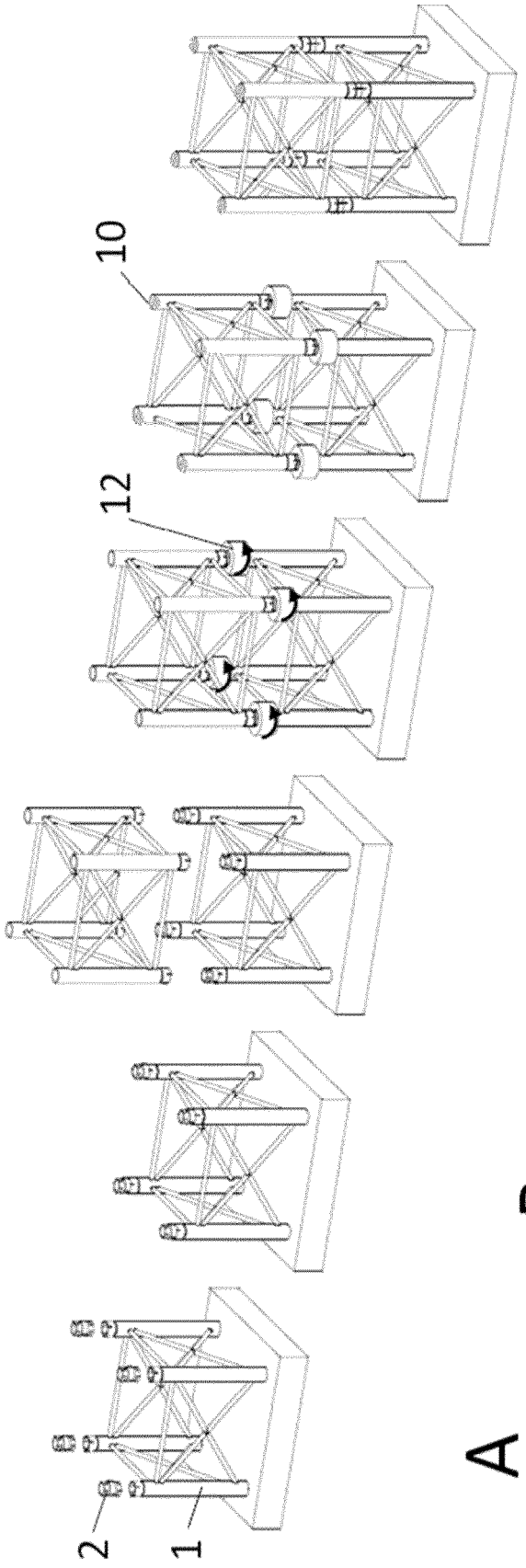
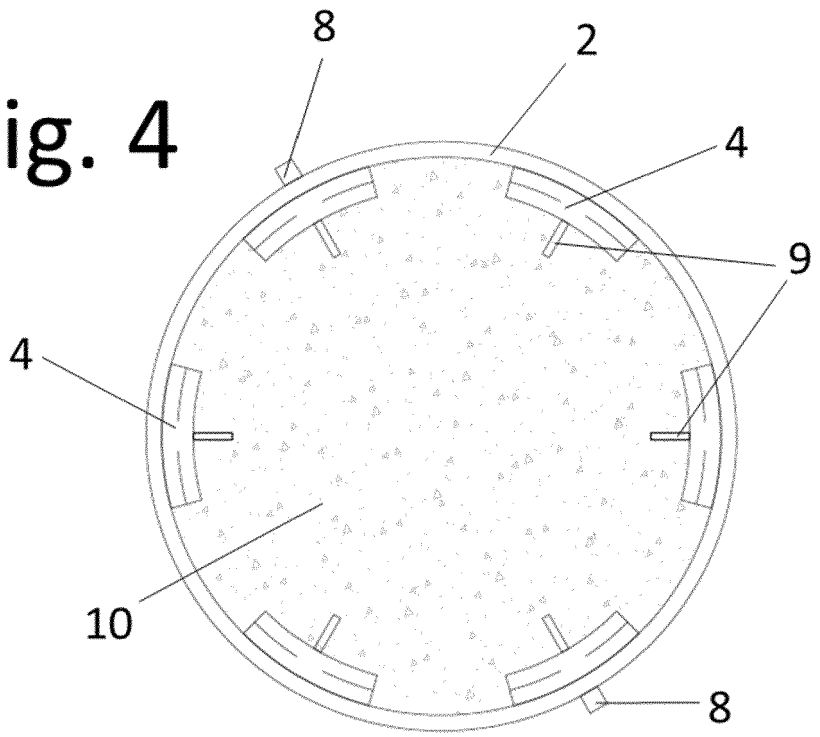
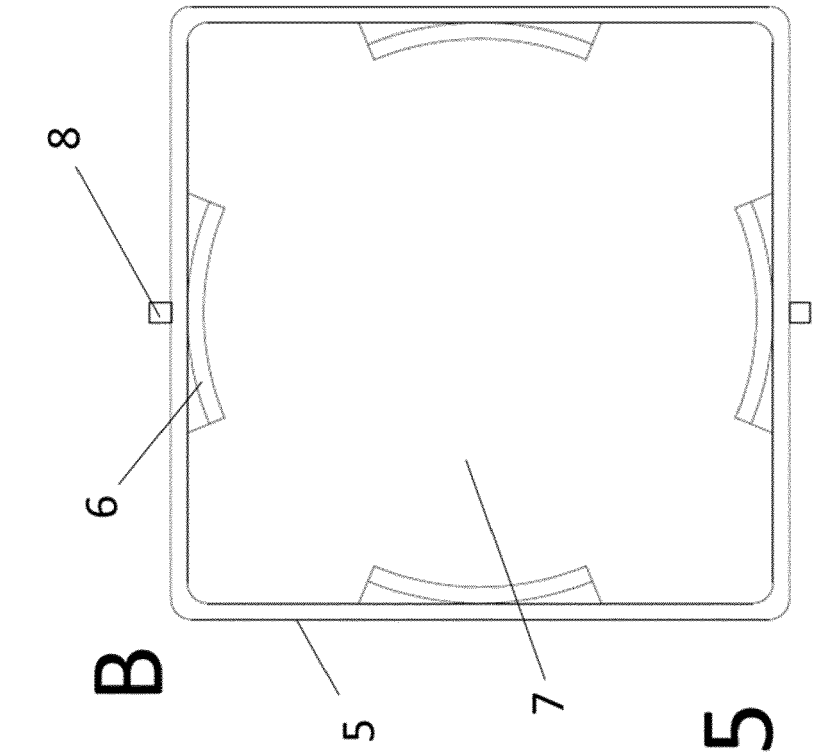


Fig. 3

Fig. 4





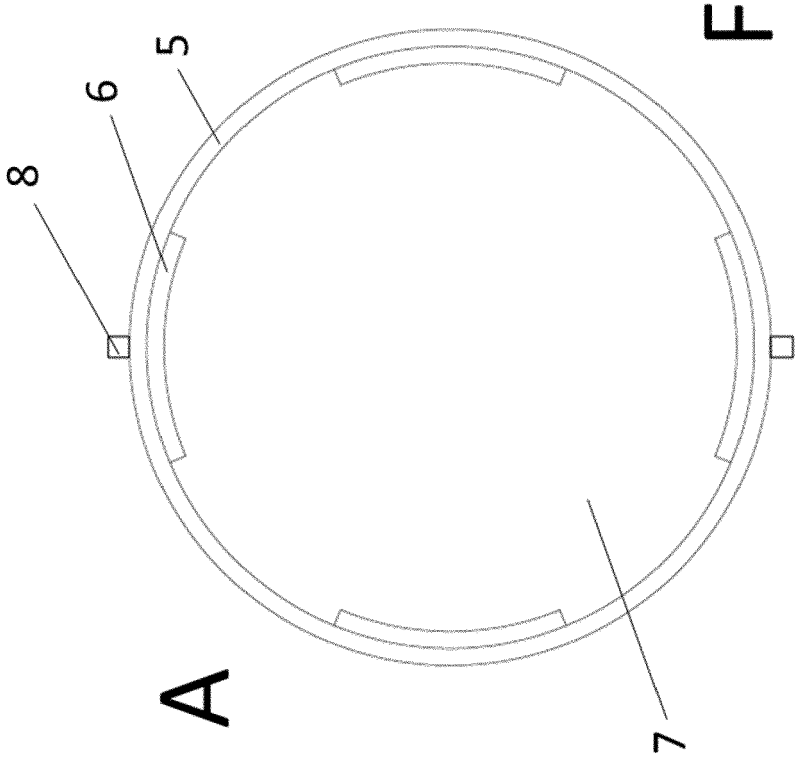


Fig. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 20 38 3009

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2019/376273 A1 (MOU BEN [CN] ET AL) 12 December 2019 (2019-12-12) * paragraph [0038] - paragraph [0042]; figures 1,2 *	1-6	INV. E04B1/24
X	JP 2011 220049 A (CHIYODA GEOTECH CO LTD) 4 November 2011 (2011-11-04) * paragraph [0011] - paragraph [0025]; figures 1,2,5-7 *	1,3,4	

TECHNICAL FIELDS SEARCHED (IPC)

E04B
E04C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	16 April 2021	Melhem, Charbel

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 20 38 3009

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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16-04-2021

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